

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)
)
Spectrum Horizons) **GN Docket No. 18-21**

To: The Commission

COMMENTS OF ROBERT BOSCH LLC

Robert Bosch LLC (Bosch), by counsel and pursuant to Section 1.415 of the Commission's Rules (47 C.F.R. §1.415), hereby respectfully submits its comments in response to the *Notice of Proposed Rule Making and Order*, FCC 18-17, 83 Fed. Reg. 13888, released February 28, 2018 (the Notice).¹ The Notice proposes to amend, among other regulations, the Commission's Part 15 rules with respect to the bands above 95 GHz, in order to accommodate the development of, and to enable new innovative services and technologies. Specifically, the *Notice* requests comment on proposed rules permitting licensed, fixed point-to-point operations in large portions of that spectrum between 95 GHz and 275 GHz; making portions of that spectrum available for unlicensed use; and creating a new type of experimental license, for the development of new services and technologies between 95 GHz and 3 THz without limits on geography or technology. For its comments in response to the *Notice* proposals and in the interests of manufacturers in a more flexible, yet internationally harmonized regulatory environment that will facilitate the development and availability of products in the millimeter-wave bands, Bosch states as follows:

¹ Because the *Notice* in this proceeding was published in the Federal Register on April 2, 2018 with a specified comment date thirty days thereafter, these comments are timely filed.

I. Introduction and Background.

1. Bosch generally supports the proposals contained in the instant rulemaking. Currently, the bands in this frequency range that are of most interest to Bosch for the development of unlicensed devices regulated pursuant to Rule Part 15 [or as more generically identified in Europe, “Short-Range Devices” (SRD)] are 122-123 GHz and 244-246 GHz. However, in the United States, the millimeter-wave bands have been typically overregulated, in that they are included in the Part 15 restricted bands pursuant to Section 15.205(a) of the Commission’s rules. Regulatory flexibility is facilitated in the bands referenced above specifically due to the extensive frequency re-use possibilities; the typically short range of communications paths; and the many opportunities for use of these bands for products with low radiated emission levels such as radiodetermination, with inherently low interference potential.

2. As an example of the problem of overregulation of these bands, Bosch has an interest in developing radiodetermination sensor products for sale in the United States which currently make use of the 122-123 GHz band. These first products would be used in industrial environments, to detect the presence of objects or products inside a tube. Were the devices classified as Part 18 Industrial, Scientific and Medical (ISM) devices, they would have been acceptable for equipment authorization and sale under current rules. However, because the devices would constitute Part 15 radiodetermination sensors, they could not be certified in the United States because the band 122-123 GHz is included in the Part 15 restricted bands, despite the absence of any predictable interference from the sensors to any other authorized user.

3. There is a substantial degree of frequency reuse possible in the band 122-123 GHz due to the high level of attenuation of signals at that frequency range² and therefore many

² The Commission notes at Paragraph 22 of the *Notice* as follows:

opportunities for spectrum overlays.³ International Footnote 5.138 to the Table of Allocations⁴ states that ISM devices centered at (among other bands) 122.5 GHz and 245 GHz should be authorized by administrations by special authorization in agreement with other administrations whose radiocommunication services might be affected. There is no indication however that any administrations bordering the United States would be harmed by authorizing radiodetermination short range devices operating on an unlicensed basis at 122.5 GHz or 245 GHz as a center frequency under Part 15.

4. There are many innovative applications that would be available right now which operate in the bands above 95 GHz, but for the inclusion of those bands among the Part 15 restricted bands for intentional radiators. These applications principally include, as examples, radiodetermination applications such as foreign object detection; living object (i.e. physical presence) detection; vehicle driver state sensors (which can reveal driver medical conditions or the position of the driver); gesture control and recognition for use inside vehicles, and home automation systems. Such sensors within the millimeter-wave range can also be used for such industrial applications as high-resolution obstacle detection for autonomous systems (such as

The propagation of millimeter wave radio signals is limited when compared to that associated with lower-frequency radio signals. Signals in millimeter wave bands are significantly affected by the presence of oxygen and water vapor within the atmosphere, although the amount of signal attenuation due to oxygen and water vapor varies with frequency and other factors. Attenuation caused by oxygen is significant throughout the millimeter wave spectrum, but increases dramatically around 60 GHz, 120 GHz, and 183 GHz.

³ See, for example, CEPT Electronic Communications Committee (ECC) Document ECC Report 90 entitled *Compatibility between Short-Range Devices (SRD) and EESS (passive) in the 122 to 122.25 GHz band* (approved May 2013).

⁴ That Footnote reads as follows:

5.138 The following bands:

122-123 GHz (centre frequency 122.5 GHz), and

244-246 GHz (centre frequency 245 GHz)

are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations.

industrial robots); displacement measurement (for example, fuel injection diameter changes or thickness measurements) and flow measurement. These are just a few examples. Resolution of this proceeding is necessary in order to permit a very significant expansion of industrial, commercial and personal products and applications using these bands for radiodetermination purposes. Generally speaking, these use cases are permitted in Europe now due to more flexible regulatory provisions than exist under current Commission rules. According to ETSI System Reference Document TR-103-498 – v.1.1.1.⁵:

(The use of microwaves provides) a very robust measuring principle which is preferred when high accuracy is required and environmental conditions, such as temperature, pressure, etc., may vary. Some of the main advantages of microwave technology for all kinds of sensors are therefore:

- high measurement accuracy,
- high repeatability,
- robust measuring performance in a variety of environmental- and process conditions,
- high reliability,
- minimum or even no maintenance requirements and wear as a result of no moving parts,
- easy installation,
- non-contact measuring principle provides a high independency of ambient conditions or process properties,
- superior long-term stability resulting from self-calibration mechanisms since devices have always stable internal references which are independent of temperature or humidity,
- efficient handling of many devices due to the support of different interfaces, the antenna or the radome is usually very robust against contamination with dust, dirt or other adverse environmental influences.

All these factors combined provide a technology that over time has proven to bring improvements in environmental protection, human safety, accident prevention and avoidance as well as a more efficient and sustainable use of natural resources and higher quality of end-products in different manufacturing industries.

⁵ This system reference document is titled *Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission characteristics; Radiodetermination applications within the frequency range 120 GHz to 260 GHz*. It provides an excellent recitation of the potential use cases for millimeter wave spectrum.

5. At paragraph 54 of the *Notice*, the Commission asks whether it should allow unlicensed operation in the 122-123 GHz and the 244-246 GHz bands, noting that they are already designated ISM bands which host devices that are not subject to emissions limits. As part of this proposal, the 122-123 GHz and 244-246 GHz bands would be removed from the list of restricted bands in Section 15.205. Bosch recommends strongly that the Commission proceed with this proposal, and as well to adopt harmonized rules for unlicensed devices generally in these bands worldwide, most urgently for radiodetermination purposes. The new rules for these two bands should be flexible, yet sufficient to protect incumbent licensed radio services; and they should make provision for expanded Part 15 use of, *at minimum*, 122-123 GHz and 244-246 GHz. Additionally, the Part 15 regulations adopted in this proceeding should be, to the greatest extent possible, harmonized with those of CEPT. Finally, the Commission should consider, in this proceeding or separately in the very near future, permitting Ultra-Wideband (UWB) device operation around 122 GHz (and in other bands) as proposed in the cited ETSI System Reference document.⁶

II. Part 15 Rules Permitting Unlicensed RF Devices to Operate in these Bands Should Be Consistent with Current Regulations in Europe to Facilitate International Harmonization.

6. As noted above, the bands 122-123 GHz and 244-246 GHz are included in the Section 15.205(a) list of restricted bands in the Commission's Rules. It is unclear what in particular justifies those inclusions except that all frequencies above 38.6 GHz are included in the restricted bands.⁷ A review of the Domestic Table of Allocations for the band 122.0-122.25 GHz is

⁶ Indeed, there are good and sufficient reasons to comprehensively re-evaluate in a near-term proceeding the overly restrictive Ultra-Wideband Part 15 rules that have not been reviewed in more than 12 years. Such a proceeding would be a competent vehicle to establish new opportunities for Ultra-Wideband products and devices in the millimeter-wave bands.

⁷ The Commission confirms at Paragraph 53 of the *Notice* that there was no interference-based reason for the initial inclusion of all of the bands above 38.6 GHz in the restricted bands other than administrative convenience and a lack of impact of doing so on equipment manufacturers:

unhelpful. That band is part of the 116-122.25 GHz band which is allocated domestically on a co-primary basis to the Earth exploration satellite service (passive), space research (passive) and the Inter-Satellite service. It is also available for ISM devices. The remainder, 122.25-123.0 GHz is allocated on a co-primary basis to the government and non-government fixed and mobile services and the Inter-Satellite service, and on a secondary basis to the Amateur Service and is available for use by ISM equipment. The applicable footnotes to the domestic and international table of allocations for this band provide no justification for inclusion of these bands in the restricted bands either. The bands are not proximate to any radioastronomy allocation and they host a secondary Amateur Radio allocation [permitting itinerant, unregulated operation in all parts of the allocation, using unspecified emission types and no specific power limitation relative to other bands, and with no operational restriction except a non-interference obligation with respect to the fixed, inter-satellite and mobile services per Section 97.303(p)] as well as ISM devices. This allocation scheme provides a strong indication that there are no particularly sensitive uses of the band that would preclude the addition of Part 15 devices, if not generally then in certain specific categories. Given this, and the aforementioned high level of attenuation of signals at that frequency range (notwithstanding the existence of propagation spikes near 120 GHz), it would appear that Part 15 devices generally, and radiodetermination applications specifically, could be included among the uses permitted at 122-123 GHz without any significant interference potential being created. Most of the same considerations are applicable to the 244-246 GHz band, including the existence of an Amateur Service secondary allocation.

The Commission designated the entire frequency range above 38.6 GHz as a restricted band in 1989 at a time when manufacturers were not producing equipment that transmitted in that frequency range and when there were no requirements in our rules to make measurements of RF emissions above 40 GHz because of limitations in measurement technology (footnote omitted). Designating the entire frequency range above 38.6 GHz as restricted, rather than restricting designated segments, was simply a matter of administrative convenience and had no impact on manufacturers.

7. The Notice proposal with reference to unlicensed operation is in general consistent with the current SRD regulations in CEPT countries applicable to the 122-123 GHz and 244-246 GHz bands. General SRD regulation in CEPT countries is pursuant to ERC REC 70-03, annex 1. That Recommendation speaks to three bands, the 122-122.25 GHz band (Band 1); the 122.25-123 GHz band (Band 2); and the 244-246 GHz band (Band 3). There are no peak or conducted power limits in these three bands, but the mean power limit for Band 1 is 10 dBm EIRP within the 250 MHz bandwidth and -48 dBm/MHz at antenna elevations above 30 degrees from the horizon.⁸ The mean power limit for Bands 2 and 3 is 100 milliwatts or 42 dBm EIRP. The related test procedures for SRD within these frequency ranges are available in the harmonized standard ETSI EN 305 550. However, in Europe there are plans to revise these limits for UWB applications pursuant to ETSI SRdoc TR-103-489 to -41.3 dBm/MHz and 50dBm peak EIRP, regardless of the operating environment.⁹

8. The standards reflected above are generally consistent with the *Notice* proposals and/or the existing Part 15 rules, including the proposed rule Section 15.258. The mean power limit proposed in the United States, for example, is 40 dBm EIRP. There is a peak power limit of 43 dBm for any emission proposed. Of some concern is the proposed conducted power limit of 500mW (27 dBm). The problem with this is that it is very difficult to test conducted power because there are no connectors on most radiodetermination devices for these bands. There are

⁸ These limits are measured with an RMS detector and an averaging time of 1 millisecond or less.

⁹ ETSI SRdoc TR 103 489 would apply only to unlicensed radiodetermination devices in the millimeter wave bands including the bands 120-130 GHz and 231.5-250 GHz and permitting UWB emissions. No radiocommunication devices would be permitted. The standard divides uses into three environments: (A) where individual sensors may radiate into free space outside a shielded environment or housing, in either outdoor or indoor use. Examples are living object detection and surveillance or building formation measurements with interferometric radars. (B) outdoor environments where sensors radiate always in a downward direction toward the ground outside a shielded environment. Examples include contour detection, level probing or contactless flow measurement. (C) indoor and outdoor applications emitting inside a confined and shielded environment or housing. Examples include tank level probing radars and high precision distance measurements in pneumatic cylinders. A peak power limit of 50 dBm EIRP would apply to all environments.

few external antennas. The devices are typically highly integrated on a chip. For this reason there are in Europe no conducted emission limits applicable to the bands 122-123 GHz or 244-246 GHz. The difficulty of measuring conducted limits in these bands should be taken into account in implementing revised rules for operation therein.

9. As to spurious limits, the current SRD regulation in Europe in bands above 1 GHz limits out of band emissions to – 30 dBm EIRP (per ERC Recommendation 74-01). For a possible new European UWB regulation a limit of -47dBm EIRP proposed pursuant to ETSI SRdoc TR-103-489. The current limit under Section 15.209 for out of band emissions between 40 and 200 GHz is 90 pW/cm² measured at 3 meters, which equates to -9.9 dBm EIRP. It is requested that the more flexible European out-of-band emission limits should apply to the bands 122-123 GHz and 244-246 GHz.

10. It is urged that the Commission adopt power limits and out-of-band emission limits that are consistent with those in effect now in the rest of the world, to the extent that the European standards are based on current and predicted future use cases and the compatibility analyses cited herein.

III. The Commission Should Permit Ultra-Wideband Operation in the Bands around 122-123 GHz and 244-246 GHz for Radiodetermination Applications.

11. ETSI System Reference document TR-103-498 V1.1.1 (2018) addresses UWB Radiodetermination applications within the frequency range 120 GHz to 260 GHz. In its introduction, it is noted that the document addresses requests for harmonized spectrum for sensor or radiodetermination applications using UWB technology within the frequency range 120 GHz to 260 GHz. Communications applications or hybrid applications including sensor and communications applications are not included within the scope of the document. Instead, it addresses the identified need for additional spectrum allocations for UWB radiodetermination

devices in order to cover measurement tasks which cannot be conducted adequately at the moment due to the limited bandwidth in the existing frequency allocations in the bands 122-123 GHz and 244-246 GHz. This is due in the United States to the restriction of the bands pursuant to Section 15.205(a), despite the fact that the UWB technology is already available to address the need for accurate radiodetermination devices.¹⁰ The stated intention of TR-103-498 is to create a basis for the facilitation of the “market launch of new innovative and useful radio products while avoiding any harmful interference with other radio services and equipment.” This is precisely the goal of the Commission in the instant proceeding.

12. The Commission has consistently applied a conservative approach to any expansion of the rules governing UWB technology. However, the millimeter-wave bands are particularly suited to UWB technology, with wide bandwidths and low power spectral density. The Commission asks at paragraph 57 of the *Notice* whether there are any other bands above 95 GHz that would be suitable for unlicensed use in addition to the 15.2 gigahertz of spectrum identified in the *Notice*. Specifically, the Commission asks whether it should permit unlicensed use of the 116-122 GHz band in addition to the adjacent 122-123 GHz band so as to provide a contiguous seven gigahertz band of spectrum available for unlicensed use. Bosch supports this proposal but would also suggest consideration of the band 123-140 GHz for unlicensed use in order to facilitate international harmonization of product development. Bosch agrees with the

¹⁰ At page 22 of the ETSI Recommendation is the following explanation:

The provision of new frequency bands above 120 GHz for applications like those identified in [this recommendation] goes along with the utilisation of new semiconductor technologies. The ... necessary semiconductor technologies are already available but the currently available frequency regulation is not yet usable for most of the proposed applications. The 1 GHz available bandwidth in the 122 to 123 GHz ISM-band and the 2 GHz wide ISM band from 244 to 246 GHz are in most cases not sufficient to solve the specific measurement task. The manufacturers of sensor equipment face therefore the current situation where a missing regulation constrains the development of new sensors although the technology is ready.

Commission's preliminary observation that unlicensed, and especially UWB radiodetermination applications in the 116-123 GHz band would not be inconsistent with incumbent passive services such as the EESS and SRS (passive) or the ISS. Radiodetermination in the band, and especially UWB radiodetermination would constitute a low density deployment and could be compatible with the high sensitivity of passive receivers, due to the low transmitted power levels, low power spectral density and the high level of propagation attenuation from atmospheric absorption. Therefore, sharing spectrum among radiodetermination unlicensed devices and incumbent allocated services (including active and passive services) is possible without causing interference. See also CEPT ECC Report 190, *Compatibility between Short-Range Devices (SRD) and EESS (passive) in the 122 to 122.25 GHz band*. (2013).

IV. Experimental Operations in the Millimeter Wave Bands Should Be Publicized

13. Bosch supports generally the proposal to permit a more flexible experimental authorization for the bands above 95 GHz. It is clear that experimental operations may be in support of applications not yet firmed up, and there is a greater developmental component to the kinds of experimental operation that might occur in these bands than in the lower frequency bands. For all of the reasons stated above, Bosch recommends that the Commission proceed with the proposal for a Spectrum Horizons experimental license. However, with the greater flexibility that these licenses offer in terms of duration and scope, there should be called for a greater degree of responsibility to coordinate these operations with incumbent licensees. The Commission has been diligent about calling on users of spectrum pursuant to Special Temporary Authority and in some cases Part 5 Experimental Licenses to coordinate with incumbent licensees in some cases in order to allow the incumbents to know the potential source of interference, should it be created by the experimental operation or STA. This concept should be

extended, and, prior to commencement of operation, there should be both public announcements, either by the Commission or by the Spectrum Horizons Experimental authorization holder, and there should be a coordination requirement with local incumbents prior to the commencement of operation. The Commission has not the enforcement resources to police interference in such cases and therefore, *ex ante*, the interference avoidance mechanisms should be put in place in advance and the onus placed on the experimental license holder to do necessary advance coordination.

V. Conclusions.

14. The Commission is on the right track in this proceeding. Clearly, opening the millimeter wave bands to expanded unlicensed operation, at least for radiodetermination applications, is timely and useful. Some of the bands above 95 GHz should be immediately removed from the Part 15 restricted band list in Section 15.205(a) of the Commission's rules. The technical rules governing such unlicensed operation, especially those related to use of the 122-123 GHz and 244-246 GHz bands (which are of great interest to the international manufacturing community), should be harmonized to the greatest extent possible with those in place in Europe at the moment and going forward. Widening of these two bands, and creating more flexible UWB rules so as to permit UWB applications in the bands around 122 GHz and 245 GHz will permit a large number of new, innovative products for consumers and for industry in the United States.

Therefore, the foregoing considered, Robert Bosch LLC respectfully requests that the

Commission resolve this proceeding in accordance with the recommendations contained in these comments.

Respectfully submitted,

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